fill the wiring trench; and

by means of chemical mechanical polishing, removing copper until said wiring trench is just filled and there is no copper on any exposed surface outside the trench, thereby forming said damascene structure and whereby said damascene structure is free of cracking and peeling.

A3 end

REMARKS

Examiner Vinh is thanked for his thorough search and Office Action. Reconsideration of the rejection of all claims is respectfully requested. We wish to comment on his remarks as follows:

Reconsideration is requested of all rejections based on 35 U.S.C. 112

a. Examiner states that use of the term 'predetermined' is vague and indefinite. We do not understand this. If we had simply written 'thickness' instead of 'predetermined thickness' we would have been following standard practice and no objection could have been raised. This (standard) terminology is not considered to be vague and indefinite even though the actual thickness need never be stated. By adding the adjective 'predetermined' we make the phrase **less** indefinite and **less** vague since the thickness

is now restricted to a value that is to be specified before film deposition begins. It is often the case that the thickness that is deposited is indirectly determined by the value of some quantity other than thickness itself. For example by the sheet resistance value. By qualifying our thickness as 'predetermined' we exclude indirect thickness values of this type.

b. Examiner states that "black diamond" is a trademark/trade name. The term "black diamond" has become a term of art being (as stated in our specification on page 2 lines 3-4) understood by skilled practitioners of the art to mean 'methyl-doped porous silica'. The statement by Li et al. notwithstanding, the name 'black diamond' no longer implies where such a material may be obtained. If Applied Materials ever had a copyright on the name 'black diamond' it has now been lost. Use of similar terms is widespread in technology. Examples that spring to mind include 'black light' for ultraviolet' and 'green ceramic' for 'uncured ceramic'.

Reconsideration is requested of all rejections based on 35 U.S.C. 103:

<u>Concerning claim 1</u>: Examiner relies on Cheung et al. as teaching that a low k dielectric film may be deposited by PECVD at low and/or high RF power levels. Even without Cheung, we would agree with this as it is self-evident and is not the key novel

feature of the present invention which is the repeated alternation of depositions at relatively low and relatively high power levels.

Examiner then cites Rana et al. as teaching said key feature of our invention. The section in question (col. 7 lines 54-66) is as follows: "This mixture is introduced into the reaction chamber from the gas distribution manifold and excited into a plasma state. The plasma is formed using a frequency of 13.56 MHz at between 0-500 Watts, and preferably at about 155 watts, and a low radio frequency of between 10 KHz and 2 MHz, preferably about 350 KHz, powered at between 0-900 Watts and preferably at about 230 Watts. The ratio of TEFS and TEOS is between 0.33-10:1 and preferably between about 1-3:1. The total flow rate of all gaseous sources is between 500-6500 sccm and is preferably between about 1500-2500 sccm. The above conditions result in an FSG film deposited at a rate of between 3000-7000 Å/minute...."

Examiner then argues that this teaches deposition at "low and higher power level(s)". We disagree with Examiner's interpretation of Rana et al. for several reasons:

a. What does it mean to deposit at low AND higher power level? Depositing "at low power and high power" simply means depositing only at high power.

b. Since Examiner obviously knows this, we assume that he interprets Rana et al. to mean that they deposit at low power OR high power. While not conceding to Examiner the right to change what Rana et al. actually say, this still does not lead to a teaching of

depositing at one power level then depositing at a second, higher, power level. At best, Rana et al. teach the same thing as Cheung et al. -- that it is possible to deposit at different power levels.

c. Examiner has no doubt noticed that Rana et al. teach using 13.56 MHz for deposition at about 155 watts and 350 KHz for deposition at about 230 Watts. This is because, for the same power level, 13.56 MHz generates more ions than does 350 KHz so, to obtain the same deposition rate, it is necessary to use more power at the lower frequency. However, were we to amend our claim to read 'effective power' this would very likely be rejected by Examiner as vague and indefinite.

d. Even if Examiner were to interpret Rana et al. as teaching that low power and then high power may be used when depositing the same film (which clearly they do not), one thing that cannot be changed is that they also teach that lower power is to be applied at 13.56 MHz and higher power at 350 KHz . Thus, one skilled in the art would, when following Rana et al.'s teaching, have to change the discharge frequency every time he changed the power level. We have, accordingly, amended all our independent claims to reflect that, in the present invention, there are no intervening steps between changes in power level.

<u>Concerning claim 8</u>: Examiner states " Regarding claim 8, since it is known in the art that oxide /low dielectric constant material has a flat band voltage of -1.82 V exhibiting a low leakage current density it would have been obvious to one skilled in the art to

employ a low dielectric constant material having a flat band voltage that is less than about-3 V to achieve lower leakage current density (see prior art of record)".

The prior art of record to which Examiner refers is Reber et al. (col 7 lines 14-15) which states "...that the thermal oxide has a flat band voltage of V_{fb}=-1.82,...". Our claim 8 reads "The process recited in claim 1 wherein the layer of low dielectric constant material has a flat band voltage that is less than about -3 volts". Thermal oxide is NOT a low dielectric constant material (see definition in our specification at the top of page 2) nor is it formed through plasma enhanced vapor deposition. In fact, the entire thrust of the present invention has been to produce a low k dielectric, formed through PECVD, that has a flat band voltage comparable to that of thermal oxide.

Concerning claim 9: The same arguments presented above in defense of claim 1 also apply here. In addition, claim 9 restricts deposition time per power level to about 10 seconds and deposited thickness per power level to between about 700 and 1,000 Angstroms. Examiner has argued that these deposition times and thicknesses are mere matters of routine optimization because deposition time and thickness "are known to affect the rate and quality". It is one thing to optimize deposition and thickness for a single layer, but we know of no prior art teaching that relates to optimizing non-uniform films made up of multiple layers. Therefore, until Examiner cites such art, we must respectfully disagree with him on this point.

Concerning claim 13: The same arguments presented above in defense of claim 8 also apply here.

Concerning claim 14: The same arguments presented above in defense of claim 9 also apply here. In addition, Examiner has cited no prior art that teaches a process that uses a low k dielectric in a damascene structure and that also causes the latter to be free of cracking and peeling.

Concerning claim 18: The same arguments presented above in defense of claim 8 also apply here.

In conclusion, we again thank Examiner Vinh for his careful reading of our application. Reconsideration and withdrawal of the rejection is respectfully requested. Allowance of all Claims is requested. It is also requested that should Examiner Vinh not find that the Claims are now Allowable, he should please call the undersigned Attorney at (845)-452-5863 to overcome any problems preventing Allowance.

Respectfully submitted

SBA

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the claims:

Please amend the following claims:

1. A process for forming a layer of low dielectric constant material having a predetermined thickness, comprising:

depositing a first layer of low dielectric constant material by means of plasma enhanced vapor deposition, at a first power level;

then, with no intervening steps, depositing a second layer of the low dielectric constant material by means of plasma enhanced vapor deposition, at a second power level that is higher than said first power level; and

repeating the preceding two steps until the predetermined thickness is reached.

9. A process for depositing a layer of black diamond on a silicon wafer to a predetermined thickness, comprising:

through chemical vapor deposition, from a first gaseous mixture of methyl silane and nitrous oxide, enhanced by a helium plasma at a power level that is less than about 70 watts, depositing a low power layer of black diamond for about 10 seconds, thereby forming a layer having a thickness between about 700 and 1,000 Angstroms;

then, with no intervening steps, through chemical vapor deposition, from a second gaseous mixture of methyl silane, nitrous oxide, and oxygen, enhanced by a helium plasma at a power level of between about 70 and 200 watts, depositing a high power layer of black diamond for about 10 seconds, thereby forming a layer having a thickness between about 700 and 1,000 Angstroms; and

repeating the preceding two steps until said predetermined thickness is reached.

14. A process for forming a dual damascene structure on a silicon wafer, comprising:

through chemical vapor deposition, from a first gaseous mixture of methyl silane and nitrous oxide, enhanced by a helium plasma at a power level that is less than about 70 watts, depositing a low power layer of black diamond for about 10 seconds, thereby forming a layer having a thickness between about 700 and 1,000 Angstroms;

then, with no intervening steps, through chemical vapor deposition, from a second gaseous mixture of methyl silane, nitrous oxide, and oxygen, enhanced by a helium plasma at a power level of between about 70 and 200 watts, depositing a high power layer of black diamond for about 10 seconds, thereby forming a layer having a thickness between about 700 and 1,000 Angstroms;

repeating the preceding two steps until a completed black diamond layer has been formed;

patterning and etching said completed black diamond layer in order to form a wiring trench;

patterning and etching said wiring trench down to the level of the silicon wafer, thereby forming a via hole;

depositing a layer of copper to a thickness sufficient to fill the via hole and to over-fill the wiring trench; and

by means of chemical mechanical polishing, removing copper until said wiring trench is just filled and there is no copper on any exposed surface outside the trench, thereby forming said damascene structure and whereby said damascene structure is free of cracking and peeling.